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(54) Surface mounting antenna and communication apparatus using the same antenna

(57) A surface mounting antenna in which easy formation of a radiation electrode (5) can be achieved by forming it on the surface of a substrate, and also the antenna can be downsized by bending the radiation electrode. A communication apparatus using the above antenna is also disclosed. A ground terminal (2) and a feeding terminal (3) are separately disposed on one lateral surface (1a). A loading capacitor electrode (4) is formed on another lateral surface (1b) opposedly facing the surface on which the ground terminal (2) and the feeding terminal (3) are disposed. A stripline radiation electrode (5) is further formed on the obverse surface of the substrate and is connected at the respective ends to the ground terminal (2) and the loading capacitor electrode (4). A feeding electrode (6) for connecting the matching portion (5d) of the radiation electrode (5) and the feeding terminal (6) is disposed on the obverse surface of the substrate (1).

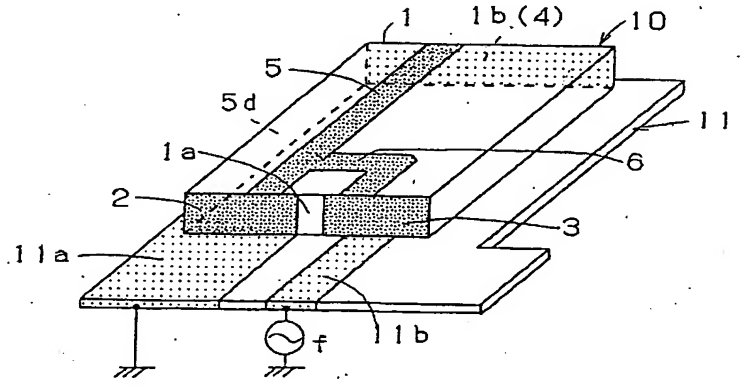

FIG. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a surface mounting antenna for use in mobile communication apparatus, such as mobile cellular telephones and radio Local Area Networks (LAN). The invention also relates to a communication apparatus using the above type of antenna.

2. Description of the Related Art

Referring to Fig. 9, a typical surface mounting antenna of a known type generally indicated by 20 has a substrate 21. A ground terminal 22 and part of a feeding terminal 23 are disposed on one lateral surface 21a of the substrate 21. The remaining feeding terminal 23 is provided on another lateral surface 21c adjacent to the lateral surface 21a. A loading capacitor electrode 24 is disposed on a lateral surface 21b opposedly facing the lateral surface 21a. A through hole 25 is formed between the opposedly-facing surfaces 21a and 21b so as to receive a radiation electrode 25a therein. This radiation electrode 25a is electrically connected to both the ground terminal 22 and the loading capacitor electrode 24. Further, a through hole 26 is formed from the lateral surface 21c to the through hole 25 so as to receive a feeding electrode 26a therein. The feeding electrode 26a is electrically connected to both the feeding terminal 23 and the radiation terminal 25a.

The surface mounting antenna 20 constructed as described above is placed on a printed circuit board 27 on which electrodes 27a and 27b are disposed. The ground terminal 22 and the feeding terminal 23 are then soldered to the electrodes 27a and 27b, respectively.

A high-frequency signal applied to the radiation electrode 25a via the electrode 27b, the feeding terminal 23 and the feeding electrode 26a is radiated as radio waves from the radiation electrode 25a. Radio waves impinging on the radiation electrode 25a are transmitted to a high-frequency amplifying section (not shown) via the feeding terminal 23 and the electrode 27b.

The surface mounting antenna 20 of the above known type requires the provision of the two through holes 25 and 26 and further necessitates complicated means for forming the radiation electrode 25a and the feeding electrode 26a in the respective holes 25 and 26, thus leading to an increase in cost. In particular, the radiation resistance and the reactance component of the radiation electrode 25a formed within the through hole 25 are generated and determined depending on the diameter of the hole 25. The diameter of the through hole 25 can be decreased to enhance the effect of the shorter wavelength, so that the antenna can be downsized, but on the other hand, this makes it difficult to form the radiation electrode 25 within the through hole 25. Hence, there is a limitation on downsizing the antenna, which further restricts the determination of the characteristic parameters. Restrictions are also imposed on the shape of a hole which is only limited to a straight hole, thus making it impossible to form the radiation electrode in an elongated shape or in different shapes. Additionally, a conventional communication apparatus integrated with the surface mounting antenna of the above known type accordingly presents the problem that the housing for the apparatus cannot be downsized.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a surface mounting antenna in which easy formation of a radiation electrode can be achieved by forming it on the obverse surface of a substrate, and the radiation electrode is further bent so as to downsize the antenna, and also to provide a communication apparatus using the above type of surface mounting antenna.

In order to achieve the above object, according to one aspect of the present invention, there is provided a surface mounting antenna comprising: a substrate formed of a dielectric member or a magnetic member; a radiation electrode disposed on one main surface of the substrate and having a matching portion; a feeding electrode disposed on the main surface of the substrate and directly connected to the matching portion of the radiation electrode or capacitively coupled to the matching portion via a gap; a loading capacitor electrode disposed on one lateral surface of the substrate and connected to one end of the radiation electrode; a ground terminal disposed on any one of the lateral surfaces other than the lateral surface on which the loading capacitor electrode is disposed, and connected to the other end of the radiation electrode; and a feeding terminal disposed on at least one lateral surface other than the lateral surface on which the loading capacitor electrode is disposed, and connected to the feeding electrode.

According to another aspect of the present invention, there is provided a surface mounting antenna comprising: a substrate formed of a dielectric member or a magnetic member; a radiation electrode disposed on one main surface of the substrate and having a matching portion; a feeding electrode disposed on the main surface of the substrate and directly connected to the matching portion of the radiation electrode or capacitively coupled to the matching portion via a gap; a loading capacitor electrode disposed on one lateral surface of the substrate and connected to one end of the radiation electrode; a ground terminal disposed on the lateral surface on which the loading capacitor electrode is disposed and connected to the other end of the radiation electrode; and a feeding terminal disposed on the lateral surface on which the loading capacitor electrode is disposed and connected to the feeding electrode.

According to still another aspect of the present invention, there is provided a surface mounting antenna

in which the radiation electrode may be formed in the shape of a stripline, "U", meandering or a crankshaft.

According to a further aspect of the present invention, there is provided a surface mounting antenna comprising: a substrate formed of a dielectric member or a magnetic member; a radiation electrode disposed on a first lateral surface of the substrate; a feeding electrode disposed in the inner periphery of a through hole formed between the first lateral surface and a second lateral surface opposing the first lateral surface; a loading capacitor electrode disposed on a lateral surface adjacent to the first lateral surface and connected to one end of the radiation electrode; a ground terminal disposed on another lateral surface adjacent to the first lateral surface and connected to the other end of the radiation electrode; and a feeding terminal disposed on at least the first lateral surface and connected to the feeding electrode.

The present invention also provides a communication apparatus loaded with any one of the surface mounting antennae according to the above-described aspects of the present invention.

In this manner, according to the present invention, a radiation electrode is formed in the shape of a stripline or meandering on a main surface or a lateral surface of a substrate, thus making it possible to shorten the wavelength. A loading capacitor electrode is disposed on a lateral surface of the substrate so as to further shorten the wavelength, thereby enhancing the downsizing of the antenna. Further, the radiation electrode is bent to reduce the chip size of the antenna to a greater degree. Additionally, the radiation electrode is disposed on the obverse surface of the substrate and the loading capacitor electrode is provided on the lateral surface, thereby enhancing easy adjustment of the characteristics of the antenna, such as frequencies and the like.

On the other hand, a communication apparatus requires only a small space for loading the surface mounting antenna apparatus of the present invention, thereby making the presence of the antenna substantially unnoticeable from the exterior.

Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a surface mounting antenna according to a first embodiment of the present invention;

Fig. 2 is a perspective view of a surface mounting antenna according to a second embodiment of the present invention;

Fig. 3 is a perspective view of a surface mounting antenna according to a third embodiment of the present invention;

Fig. 4 is a perspective view of a surface mounting antenna according to a fourth embodiment of the present invention;

Fig. 5 is a perspective view of a surface mounting antenna according to a fifth embodiment of the present invention;

Fig. 6 is an electrical equivalent circuit of each of the embodiments shown in Figs. 1 through 4;

Fig. 7 is an electrical equivalent circuit of the fifth embodiment shown in Fig. 5;

Fig. 8 is a perspective view of a communication apparatus of the present invention; and

Fig. 9 is a perspective view of a conventional surface mounting antenna.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention will now be described with reference to the drawings. Referring to Fig. 1 illustrating a first embodiment of the present invention, a surface mounting antenna generally designated by 10 has a rectangular substrate 1 formed of a dielectric material, a magnetic material or the like. A ground terminal 2 and a feeding terminal 3 are separately disposed on a lateral surface 1a of the substrate 1. A loading capacitor electrode 4 is formed on another lateral surface 1b opposedly facing the lateral surface 1a. Disposed on the obverse surface of the substrate 1 is a stripline radiation electrode 5 connected at the respective ends to the ground electrode 2 and the loading capacitor electrode 4. Also formed on the obverse surface of the substrate 1 is a bent feeding electrode 6 connected at one end to a matching portion 5d of the radiation electrode 5 and at the other end to the feeding terminal 3.

The surface mounting antenna 10 constructed as described above is placed on, for example, a printed circuit board 11 on which electrodes 11a and 11b are formed. The ground terminal 2 and the feeding terminal 3 are soldered to the electrodes 11a and 11b, respectively.

The electrical equivalent circuit of the above antenna can be schematically indicated as shown in Fig. 6. A loading capacitor C generated between the ground terminal 2 and the loading capacitor electrode 4, a radiation resistor R and an inductor L of the radiation electrode 5 are connected in parallel to each other so as to form a parallel resonant circuit. A high-frequency signal f applied to the radiation electrode 5 via the electrode 11b of the board 11, the feeding terminal 3 and the feeding electrode 6 produces parallel resonance and is radiated as radio waves from the radiation electrode 5.

An explanation will now be given of a second embodiment of the present invention while referring to Fig. 2. The surface mounting antenna 10a of the second embodiment differs from the first embodiment in that the radiation electrode 5a is formed in the shape of a crankshaft. The other constructions are similar to those of the first embodiment. The same and corresponding elements as those of the first embodiment are designated by like reference numerals, and an explanation thereof will thus be omitted. The electrical equivalent circuit of the antenna 10a can also be indicated as illustrated in Fig. 6, as in the first embodiment.

This embodiment is advantageous over the first embodiment because the radiation electrode 5a is lengthened by forming it in the shape of a crankshaft so as to cope with lower frequencies having the same chip size as the first embodiment. This makes it possible to further downsize the chip size of the antenna at the same frequency as the first embodiment.

A third embodiment of the present invention will now be described with reference to Fig. 3. The surface mounting antenna 10b of the third embodiment is different from the first embodiment in that the feeding terminal 3 and the matching portion 5e of the radiation electrode 5 are connected to each other on the same lateral surface 1a, and that the ground terminal 2 and the feeding terminal 3 are connected to each other by means of a narrow electrode. The same and corresponding components similar to those of the first embodiment are designated by like reference numerals, and an explanation thereof will thus be omitted. The electrical equivalent circuit of the antenna 10b can also be indicated as shown in Fig. 6, as in the first embodiment.

A fourth embodiment of the present invention will now be described with reference to Fig. 4. The surface mounting antenna 10c of this embodiment differs from the first embodiment in the following respects. The feeding terminal 3a is disposed across both the lateral surfaces 1a and 7a adjacent to each other, while the stripline radiation electrode 5b is provided on another lateral surface 7b close to the lateral surface 1a. A through hole 8 is formed from the lateral surface 7a to the lateral surface 7b so as to receive the feeding terminal 6a therein, which is then connected at the respective ends to the feeding terminal 3a and the radiation electrode 5b. The other constructions are similar to those of the first embodiment. The same and corresponding components similar to those of the first embodiment are depicted by like reference numerals, and an explanation thereof will thus be omitted. The electrical equivalent circuit of the antenna 10c can also be indicated as shown in Fig. 6, as in the first embodiment.

An explanation will now be given of a fifth embodiment of the present invention while referring to Fig. 5. The surface mounting antenna 10d of the fifth embodiment is different from the first embodiment in the following point. The feeding electrode 6b is connected at one end to the feeding terminal 3 and is bent at the other end. The bent end of the feeding electrode 6b is placed in the vicinity of the matching portion of the radiation electrode 5 across a gap g. The feeding electrode 6b and the radiation electrode 5 are electromagnetically coupled to each other due to a capacitor generated in this gap g. The other constructions are similar to those of the first embodiment. The same and corresponding elements as those of the first embodiment are indicated by like reference numerals, and an explanation thereof will thus be omitted. The electrical equivalent circuit of this antenna 10d can be indicated as shown in Fig. 7. A series circuit of the feeding capacitor Cg of the feeding portion and a high-frequency signal f is connected in parallel to a parallel circuit of a loading capacitor C, a radiation resistor R and an inductor L implemented in the electrical equivalent circuit of the first embodiment.

Fig. 8 illustrates a communication apparatus loaded with one of the surface mounting antennae described in the respective embodiments. The surface mounting antenna 10 (10a through 10d) is mounted on a communication apparatus 9 by soldering the ground terminal 2 and the feeding terminal 3 to a printed circuit board (or its sub board) of the apparatus 9. As will be clearly understood from the foregoing description, the present invention offers the following advantages.

A radiation electrode is formed on the surface of the substrate and a loading capacitor electrode is further disposed, thereby enhancing easy formation of the electrodes and also downsizing the antenna. To further develop the present invention, the radiation electrode is formed in a meandering shape so as to further decrease the size of the antenna. Also, since the radiation electrode and the loading capacitor electrode are disposed on the surfaces of the substrate, adjustments can be readily made to the characteristics of the antenna, such as frequencies and the like.

Further, a communication apparatus requires only a small space for loading the surface mounting antenna of the present invention, thus making the presence of the antenna substantially unnoticeable from the exterior and also downsizing the apparatus itself.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. Therefore, the present invention should be limited not by the specific disclosure herein, but only by the appended claims.

Claims

1. A surface mounting antenna comprising:

a substrate (1) comprising one of a dielectric member and a magnetic member, the substrate (1) having main surfaces and lateral surfaces connecting the main surfaces (5);

a radiation electrode (5; 5a) disposed on a main surface of said substrate (1) and having a

matching portion (5d);

a feeding electrode (6; 6b) disposed on the main surface of said substrate (1) and coupled to said matching portion (5d) of said radiation electrode (5; 5a);

a loading capacitor electrode (4) disposed on a lateral surface (1b) of said substrate (1) and connected to a first end of said radiation electrode (5; 5a);

a ground terminal (2) disposed on a lateral surface (1a) of the substrate (1) other than the lateral surface (1b) on which said loading capacitor electrode (4) is disposed, and connected to a second end of said radiation electrode (5; 5a); and

a feeding terminal (3) disposed on a lateral surface (1a) of the substrate (1) other than the lateral surface (1b) on which said loading capacitor electrode (4) is disposed, and connected to said feeding electrode (6; 6b).

2. A surface mounting antenna comprising:

a substrate (1) comprising one of a dielectric member and a magnetic member, the substrate (1) having main surfaces and lateral surfaces connecting the main surfaces;

a radiation electrode (5; 5a) disposed on a main surface of said substrate and having a matching portion (5d);

a feeding electrode (6; 6b) disposed on the main surface of said substrate (1) and coupled to said matching portion (5d) of said radiation electrode (5; 5a);

a loading capacitor electrode (4) disposed on a lateral surface (1b) of said substrate (1) and connected to a first end of said radiation electrode (5; 5a);

a ground terminal (2) disposed on a lateral surface (1a) of the substrate (1) other than the lateral surface (1b) on which said loading capacitor electrode (4) is disposed and connected to a second end of said radiation electrode (5; 5a); and

at least a portion of a feeding terminal (3) disposed on the lateral surface (1a) on which said ground electrode (2) is disposed and connected to said feeding electrode (6; 6b).

3. A surface mounting antenna comprising:

a substrate (1) comprising one of a dielectric member and a magnetic member the substrate having main surfaces and lateral surfaces connecting the main surfaces;

a radiation electrode (5; 5a) disposed on a main surface of said substrate (1) and having a matching portion (5d);

a feeding electrode (6; 6b) disposed on the main surface of said substrate (1) and coupled to said matching portion (5d) of said radiation electrode (5; 5a);

a loading capacitor electrode (4) disposed on a lateral surface (1b) of said substrate (1) and connected to a first end of said radiation electrode (5; 5a);

a ground terminal (2) disposed on a lateral surface (1a) of the substrate (1) and connected to a second end of said radiation electrode (5); and

a feeding terminal (3) disposed on a lateral surface (1a) of the substrate (1) and connected to said feeding electrode (6; 6b)

4. A surface mounting antenna according to one of claims 1 to 3, wherein the feeding electrode (6) is directly coupled to the radiation electrode (5) at the matching portion (5d).

5. A surface mounting antenna according to one of claims 1 to 3, wherein the feeding electrode (6b) is capacitively coupled to said matching portion (5d) of said radiation electrode (5; 5a).

6. A surface mounting antenna according to claim 5, wherein said feeding electrode (6b) is capacitively coupled to said radiation electrode (5; 5a) across a gap (9).

7. A surface mounting antenna according to one of claims 1 to 6, wherein said radiation electrode (5; 5a) is formed in the shape of one of a stripline, "U", meandering and a crankshaft.

8. A surface mounting antenna comprising:

a substrate (1) comprising one of a dielectric member and a magnetic member, the substrate (1) having main surfaces and lateral surfaces connecting the main surfaces;

a radiation electrode (5b) disposed on a first lateral surface (7b) of said substrate (1);

a feeding electrode (6a) disposed in an inner

periphery of a through hole (8) formed between said first lateral surface (7b) and a second lateral surface (7a) opposing said first lateral surface (7b);

a loading capacitor (4) electrode disposed on a lateral surface (1a) adjacent to said first lateral surface (7b) and connected to a first end of said radiation electrode (5b);

a ground terminal (2) disposed on another lateral surface (1a) adjacent to said first lateral surface (7b) and connected to a second end of said radiation electrode (5b); and

a feeding terminal (3a) disposed on at least said second lateral surface (7a) and connected to said feeding electrode (6a).

9. A surface mounting antenna comprising:

a substrate (1) comprising one of a dielectric member and magnetic member the substrate having main surfaces and lateral surfaces connecting the main surfaces;

a radiation electrode (5) disposed on one main surface of said substrate (1) and continuing onto a lateral surface (1a) of said substrate (1) and having a matching portion (5e) on said lateral surface (1a);

a feeding electrode disposed on the lateral surface (1a) of said substrate (1) on which a portion of the radiation electrode (5) is disposed and being coupled to said matching portion (5e) of said radiation electrode (5);

a loading capacitor electrode (4) disposed on a lateral surface (1b) of said substrate (1) and connected to a first end of said radiation electrode (5);

a ground terminal (2) disposed on a lateral surface (1a) of the substrate (1) and connected to a second end of said radiation electrode (5); and

a feeding terminal (3) disposed on a lateral surface (1a) of the substrate (1) and connected to said feeding electrode (5).

10. A communication apparatus provided with a surface mounting antenna in accordance with one of claims 1 to 9.

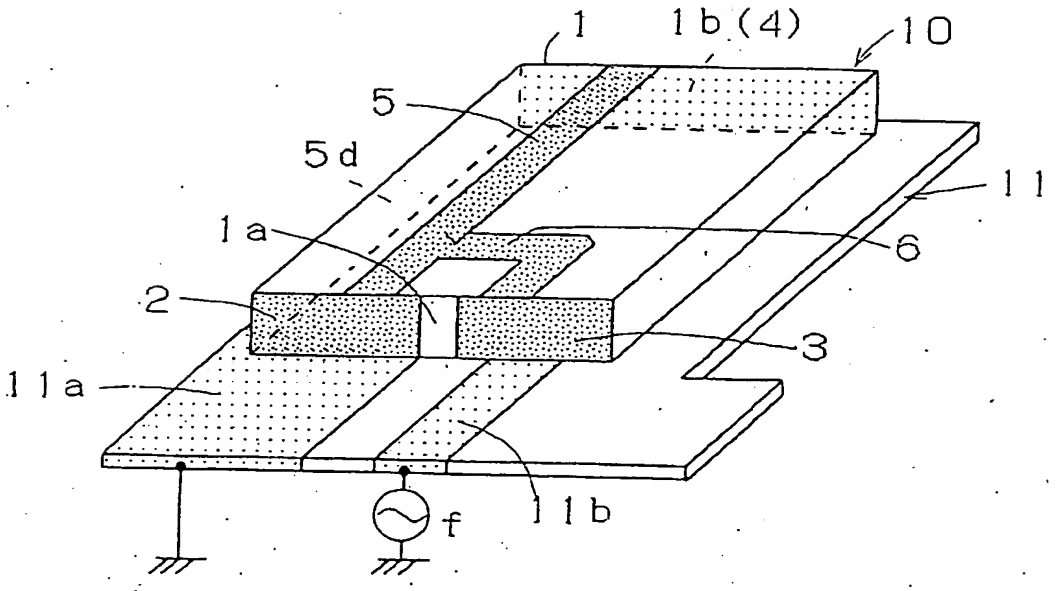

FIG. 1

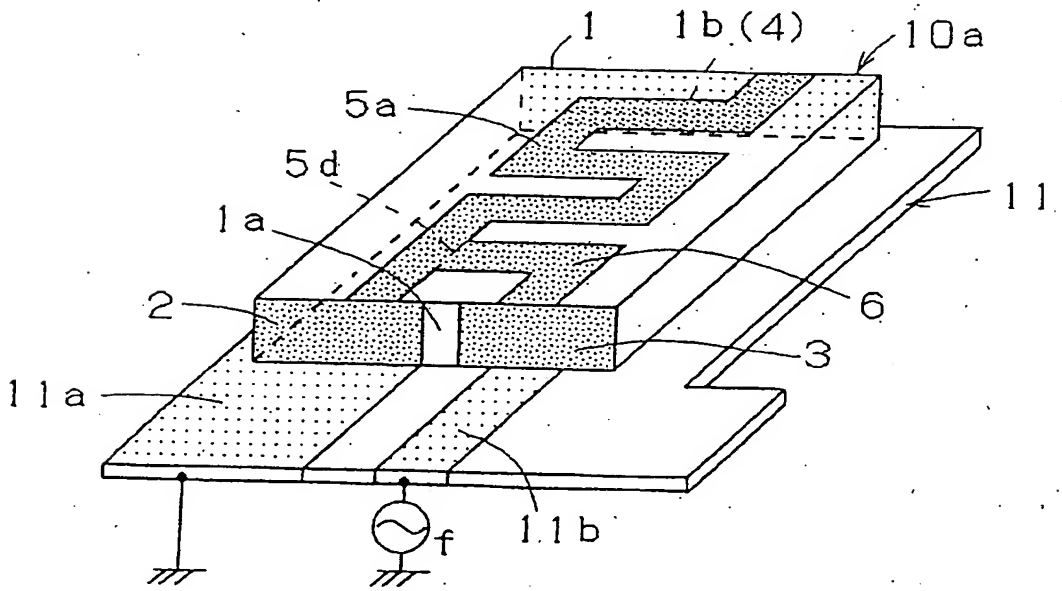

FIG. 2

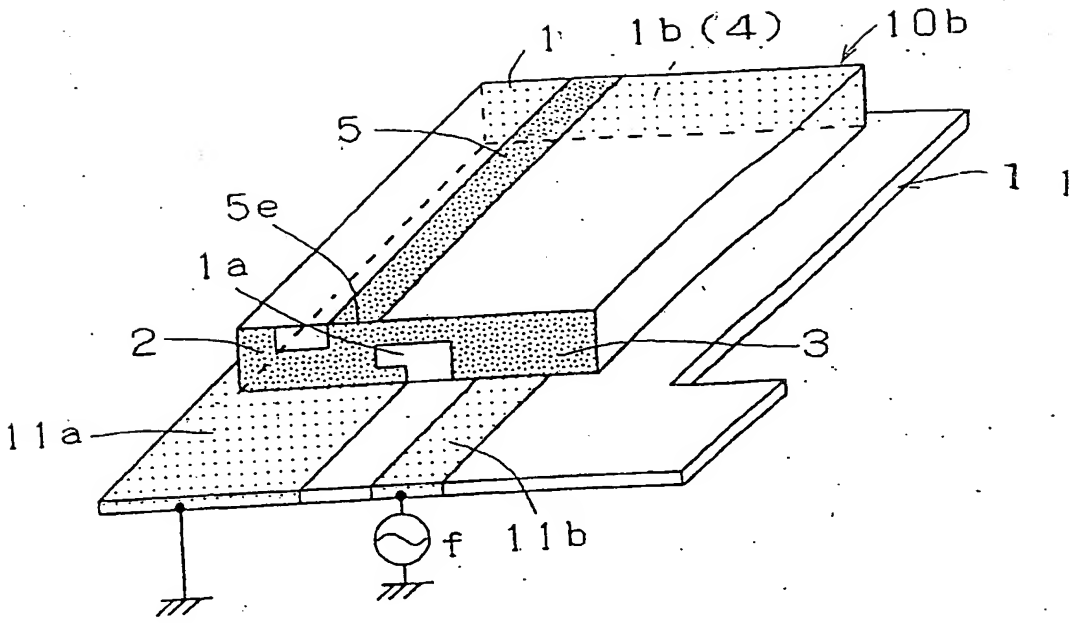
1
1b(4)
10b
5
5e
1a
2
3
11
11a
f
11b

FIG. 3

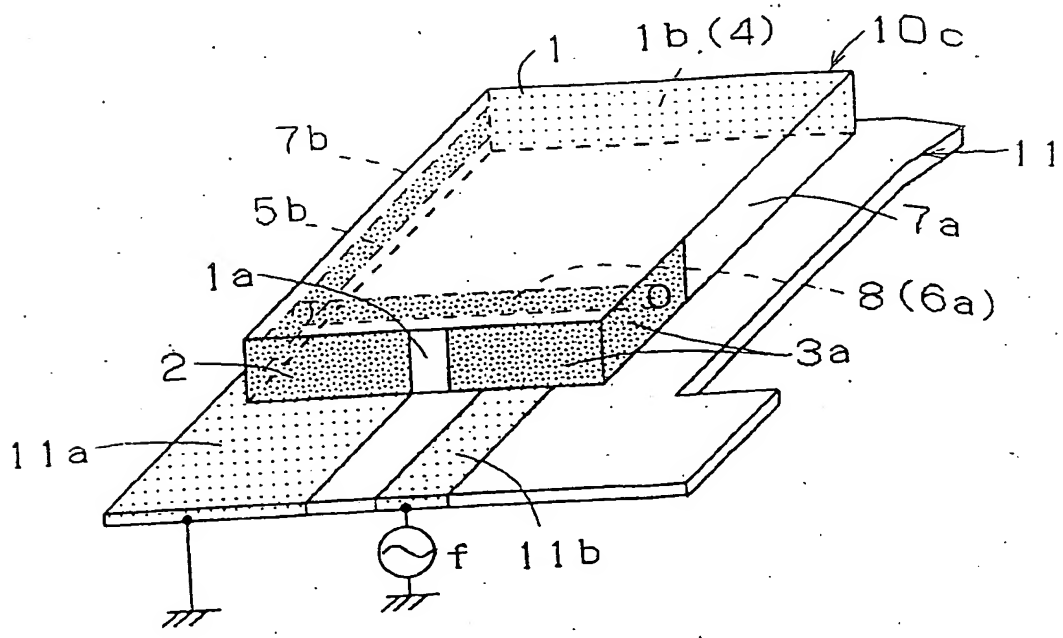
1
1b(4)
10c
7b
5b
1a
2
11a
11
7a
8(6a)
3a
f
11b

FIG. 4

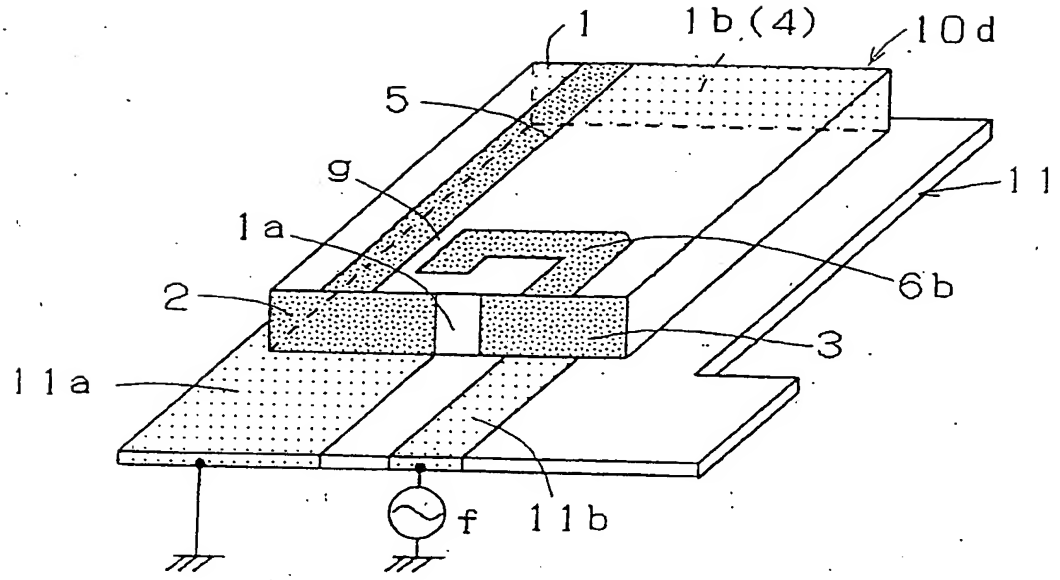

FIG. 5

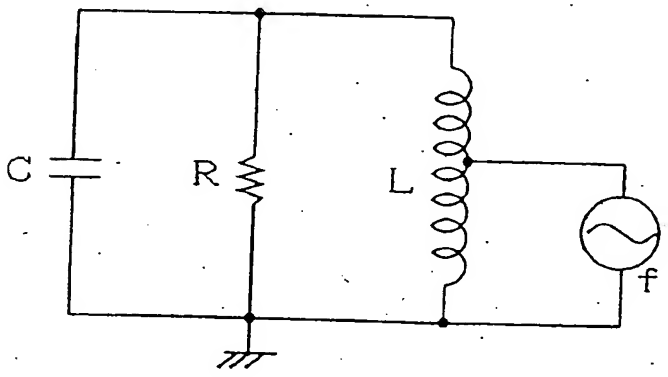

FIG. 6

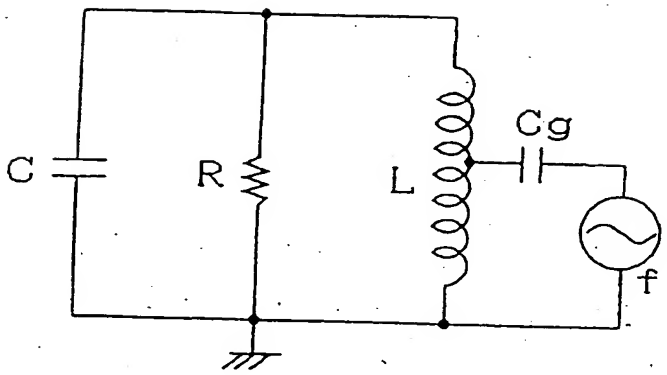

FIG. 7

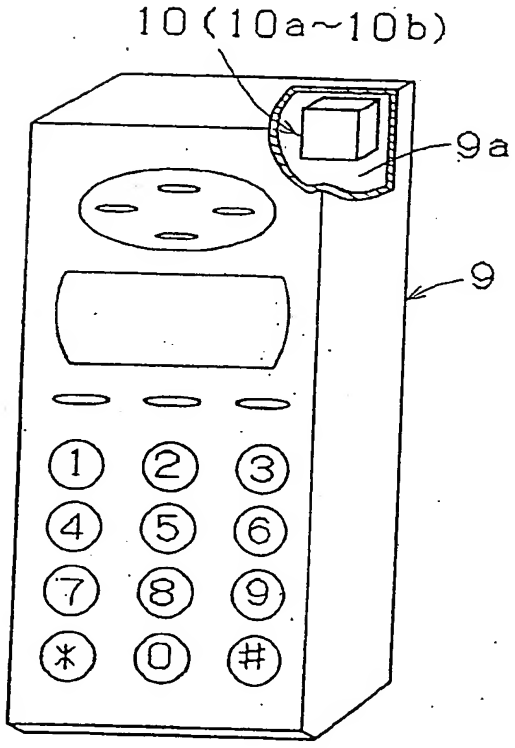

FIG. 8

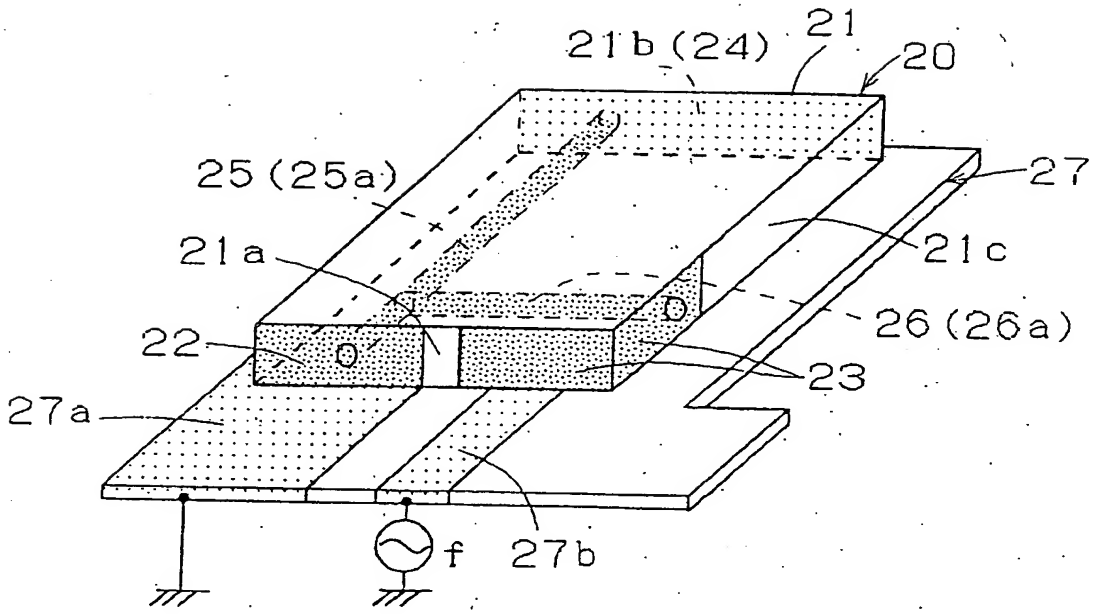

FIG. 9